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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/902,607	07/12/2001	Yeong-Kwan Kim	249/258	1299
27849	7590	04/13/2004	EXAMINER	
LEE & STERBA, P.C. 1101 WILSON BOULEVARD SUITE 2000 ARLINGTON, VA 22209			THOMAS, TONIAE M	
			ART UNIT	PAPER NUMBER
			2822	

DATE MAILED: 04/13/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

148'

<b>Office Action Summary</b>	<b>Application No.</b> 09/902,607	<b>Applicant(s)</b> KIM ET AL.	
	<b>Examiner</b> Toniae M. Thomas	<b>Art Unit</b> 2822	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 05 February 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 16-35 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 21-35 is/are allowed.
- 6) ☒ Claim(s) 16-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12 July 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All    b) ☐ Some \*    c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

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|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### DETAILED ACTION

1. This action is responsive to the after-final amendment filed on 05 February 2004. Currently, claims 16-35 are pending.
2. The finality of the Office action mailed on 05 November 2003 is withdrawn.
3. The Applicant's response filed on 05 February 2004 has overcome the rejections under 35 USC 103(a), which were made of record in the Office mailed on 05 November 2003. Therefore, the rejections have been withdrawn. However, upon further consideration, new grounds of rejection are made in view of US Patent 6,461,937 B1 (Kim et al.).

#### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. *Claims 16, 17, and 20 are rejected under 35 U.S.C. 103(a) as being obvious over Kim et al. (US 6,461,937 B1) in view of Gadgil et al. (US 5,879,459).*<sup>1</sup>

The applied reference, US 6,461,937 B1, has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 103(a)

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<sup>1</sup> The Gadgil et al. patent was relied upon in the previous Office action.

might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2).

The Kim et al. patent (Kim) discloses a method for fabricating a semiconductor device (see figs 6-10 and col. 5, line 38 – col. 7, line 40). The method comprises the following steps recited in claim 16: forming a trench 106 to a depth in a semiconductor substrate 100 (fig. 7 and col. 5, lines 60-65); forming a liner layer formed of a multi-layer of a silicon nitride layer 112 and a silicon oxide layer 110 on the sidewalls and bottom of the trench (fig. 8 and col. 6, lines 13-27); and forming a buried insulating layer 114, which fills in the trench without a void (fig. 8 and col. 6, lines 39-58).

An oxide layer 108 is formed by thermal oxidation on the sidewalls and bottom of the trench 106 before the liner layer is formed on the sidewalls and bottom of the trench, as recited in claim 20 (fig. 7 and col. 5, line 65 – col. 6, line 2).

Kim lacks anticipation in not teaching that the liner layer comprising a multi-layer of a silicon nitride layer 112 and a silicon oxide layer 110 is formed by atomic layer deposition (ALD), as recited in claim 16.

The Gadgil et al. patent (Gadgil) teaches that ALD is a better thin film coating method than the conventional CVD methods (col. 1, lines 34-37; col. 2, lines 42-49; and col. 3, lines 38-60). One advantage of using ALD is: it provides uniformity and excellent step coverage (col. 1, lines 34-37). Furthermore, ALD has the ability to maintain ultra-uniform thin deposition layers over complex topology (col. 2, lines 42-49). Gadgil also teaches that forming thin film layers without breaking vacuum is an inherent property of the ALD coating method, as recited in claim 17 (fig. 1a and col. 3, lines 5-20).

Since Kim and Gadgil are from the same field of endeavor, the purpose disclosed by Gadgil would have been recognized in the pertinent art of Kim, at the time the invention was made, by one of ordinary skill in the art.

One having ordinary skill in the art would have been motivated to modify Kim in view of Gadgil, at the time the invention was made, by forming the silicon oxide/silicon nitride multi-layer liner layer using an ALD technique, since the resulting multi-layer liner layer has uniformity and excellent step coverage.

5. *Claims 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Gadgil as applied to claim 16 above, and further in view of Wolf et al. (Silicon Processing for the VLSI Era – Vol. 1).*<sup>2</sup>

Kim does not teach that the silicon nitride layer 112 is formed using a silicon source selected from one of silane ( $\text{SiH}_4$ ), Si-alkyl, Si-halide, or Si-amide, and a nitrifying agent selected from one of ammonia, plasma ammonia, or plasma nitrogen, as recited in claim 18; or that the silicon oxide layer 110 is formed using a silicon source selected from one of silane ( $\text{SiH}_4$ ), Si-alkoxide, Si-alkyl, Si-halide, or Si-amide, and an oxidizing agent selected from one of water ( $\text{H}_2\text{O}$ ), hydrogen peroxide, ozone, plasma  $\text{O}_2$ ,  $\text{N}_2\text{O}$ , or plasma  $\text{N}_2\text{O}$ , as recited in claim 19.

The Wolf et al. reference (Wolf) discloses methods for forming both silicon nitride and silicon oxide films. Regarding the deposition of silicon oxide, silane is used as a silicon source, and  $\text{N}_2\text{O}$  as the oxidizing agent (page 184, 4th par). Regarding the deposition of silicon nitride, silane is used as a silicon source, and ammonia as the nitrifying agent (page 194, 1st par.).

One of ordinary skill in the art would have been motivated to modify the combination of Kim and Gadgil, at the time the invention was made, by forming the silicon oxide layer using silane and  $\text{N}_2\text{O}$  and forming the silicon nitride layer using silane and ammonia, as taught by Wolf, because: (1) a silicon oxide film that is formed

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<sup>2</sup> The Wolf et al. reference was relied upon in the previous action.

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by reacting silane and  $N_2O$  is less dense and has a high etch rate, and (2) a silicon oxide film that is formed by reacting silane and ammonia exhibits good step coverage.

*Allowable Subject Matter*

Claims 21-35 are allowable because the prior art of record does not anticipate, teach or suggest at least the limitation of forming a first bubble prevention layer of a multi-layer of silicon oxide and silicon nitride on gate spacers and gate stack patterns by ALD prior to forming a first filling insulating layer without void between the gate stack patterns and on the first bubble prevention layer.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Toniae M. Thomas whose telephone number is (571) 272-1846. The examiner can normally be reached on Monday-Thursday from 8:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

*TMJ*

01 April 2004

  
AMIR ZARABIAN  
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